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## 1993 Feature Article - Input-Output Tables: Describing the Shape of Australia's Economy

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### Introduction

The purpose of this article is to describe the basic structure of input-output tables, how they are put together, the uses that can be made of them and their relationship with the other components of the national accounts.

The first input-output tables for Australia were compiled for 1958-59. Since then, eleven more sets of tables have been produced. The most recent tables are for 1986-87 and those for 1989-90 are scheduled for publication in December 1993.

The main input-output publications are Australian National Accounts: Input-Output Tables (cat. no. 5209.0) and Australian National Accounts: Input-Output Tables, Commodity Details (cat. no. 5215.0). A range of input-output multipliers is published in Australian National Accounts: Input-Output Multipliers (cat. no. 5237.0). They are all currently published every three years.

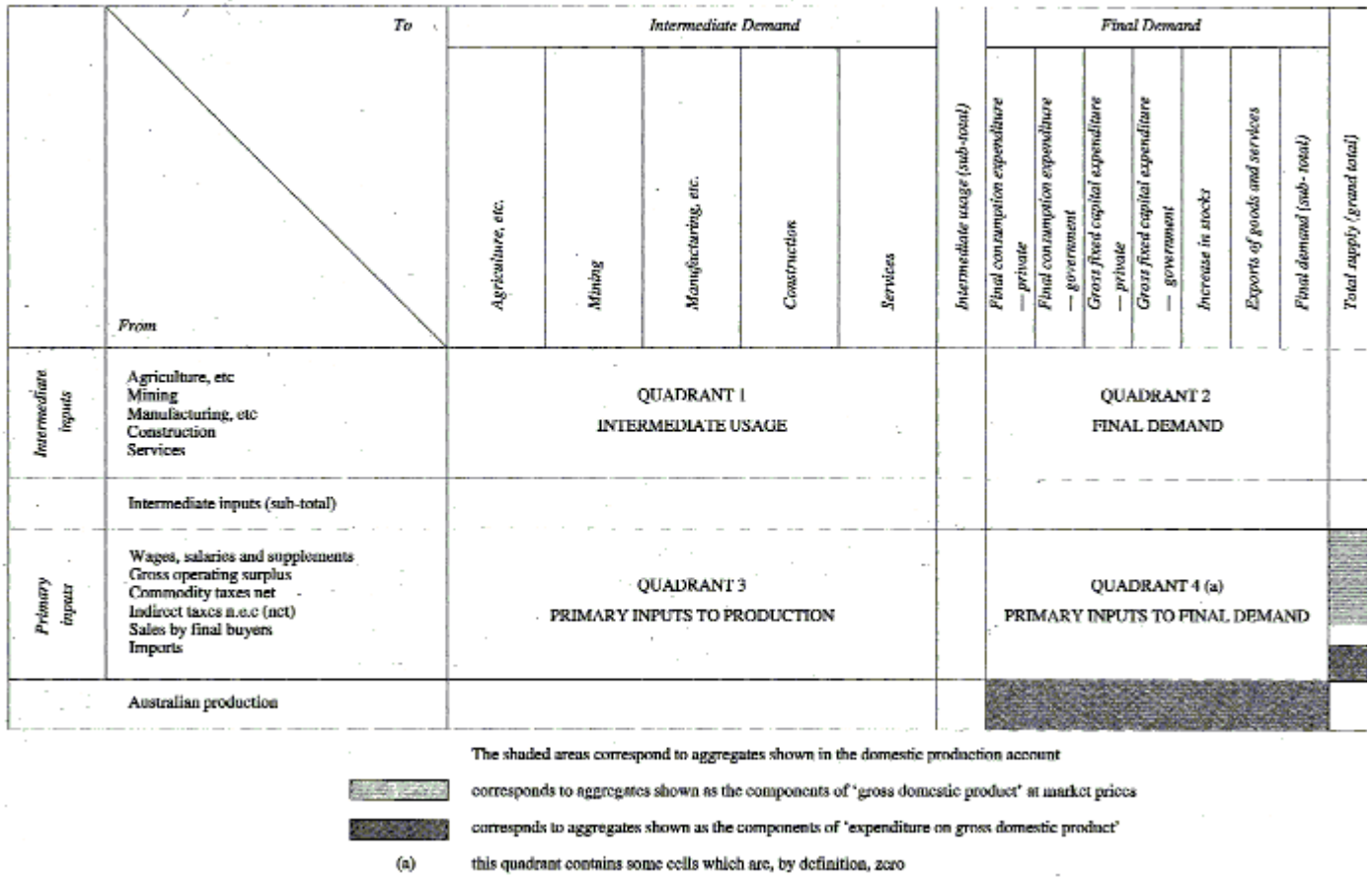
Note that a new table of employment by input-output industry will be included in the 1989-90 input-output tables publication cat. no. 5209.0. These employment data will also be used in the calculation of the employment multipliers for cat. no. 5237.0.

### Basic structure of input-output tables

Input-output tables show the structure of a country's entire production system for a particular period, usually one year. They show which goods and services are produced by each industry and how they are used (e.g. some goods, such as cars, are sold to final consumers while others, such as steel, are used as inputs by other industries in producing more goods and services). The tables are based on the principle that the value of the output of each industry can be expressed as the sum of the values of all the inputs to that industry plus any profits made. All of the goods and services produced in a period are identified as being used as inputs by industries in their production process, being sold to final users of the goods and services (either in Australia, or overseas as exports), or contributing to the change in stocks (an increase in stocks if more goods are produced than purchased or a rundown in stocks if demand exceeds supply). For the production system as a whole, the sum of all outputs must equal the sum of all inputs or, in other words, total supply must equal total demand.

Figure 1 shows the structure of a typical input-output table or "matrix". The tables may be regarded as consisting of four quadrants. Quadrant 1 (intermediate usage) shows the flows of the goods and services used up in producing other goods and services. For example, the intersection of the third row (Manufacturing) with the fourth column (Construction) shows the value of output from the Manufacturing industry which is used as input by the Construction industry.

**FIGURE 1. STRUCTURE OF AUSTRALIAN INPUT-OUTPUT TABLES, simplified example**




Quadrant 2 (final demand) provides details of the sales of goods and services by each industry to final users. For example, the intersection of the second row (Mining) with the third-last column (Exports of goods and services) identifies the value of Mining industry output that is exported.

Quadrant 3 (primary inputs to production) indicates the use in production of primary inputs such as wages, salaries and supplements, secondhand goods (sales by final buyers) and taxes paid by producers. For example, the intersection of the first row in this quadrant (wages, salaries and supplements) with the third column (Manufacturing) shows the amounts paid out to employees by businesses in the Manufacturing industry.

Quadrant 4 (primary inputs to final demand) presents information on taxes paid by final users, flows of secondhand goods to (positive sign) and from (negative sign) final buyers and imports which are subsequently exported. These so-called "re-exports" are recorded in the cell at the intersection of the row "imports of goods and services" and the column "exports of goods and services". It follows that all exports shown in Quadrant 2 are exports of domestically produced goods and services.

**Relationship to the national income and expenditure accounts**

Input-output tables can be directly related to the main summary account (referred to as the "domestic production account") in the national income and expenditure accounts, (see the annual Australian National Accounts: National Income, Expenditure and Product (cat. no. 5204.0)). The income side of the production account shows the amount of income generated in the economy accruing to labour (in the form of wages, salaries and supplements) and to capital (as profits or, in national accounting terms, "gross operating surplus"), as shown in the rows of Quadrant 3 in

Figure 1. The expenditure side of the account shows the value of goods and services entering into the various categories of final demand, as shown in the columns of Quadrant 2 in Figure 1.

The input-output tables provide a much more detailed disaggregation of the domestic production account than is available in the national income and expenditure accounts. The latter only supply details of the end results of economic activity, whereas the input-output tables provide a means of tracing flows of goods and services step by step through the production process. The extra detail provided by the input-output tables is essential for many analyses.

**Basic concepts**

For the purpose of compiling input-output tables, a production system can be considered to consist of any number of industries, depending on the analyses to be performed. However, from a statistical point of view, these industries must be defined in such a way that each industry produces its own group of characteristic outputs of goods and services, called the commodity group, said to be primary to that industry (i.e. they are produced predominantly by that industry). For example, butter is primary to the milk products industry, while beer is primary to the beer and malt industry. The input-output industry classification used in Australia is based on the Australian Standard Industrial Classification (ASIC). Details of the links between the industry classification used in the input-output tables and ASIC are provided in Australian National Accounts: Input-Output Tables (cat. no. 5209.0). Details of the input-output commodity classification are provided in Australian National Accounts: Input-Output Tables, Commodity Details (cat. no. 5215.0).

In order to compile input-output tables, the price paid by the final user, the purchasers' price, is broken down into several components. The core component is the basic value, which is the price received by the producer excluding commodity taxes. The basic value plus net commodity taxes (i.e. commodity taxes, such as sales tax, less subsidies) is the actual price received by the producer, the producers' price. To the producers' price are added various margins to give the purchasers' price. Margins include wholesale margins, retail margins and freight margins. For example, if a person buys a loaf of bread, the final price paid may include the values of various margins such as wholesale and retail margins, road freight margins (on delivery of the wheat to the railhead, delivery of the flour from the mill to the baker, and delivery of the baked bread to the shop) and rail freight margins on transport of the wheat to the mill.

Based on recommendations in the United Nations' A System of National Accounts (SNA), private households are regarded as not undertaking any capital expenditure and as not holding stocks (i.e. all their purchases of goods and services are considered to be consumed). In addition, all military expenditure is regarded as current expenditure (i.e. as government final consumption expenditure), even where the outlays on the items concerned would usually be regarded as capital expenditure, such as aircraft.

**Basic and derived input-output tables**

In Australia, the input-output tables are compiled from four basic matrices, published as Tables 1 to 4 of cat. no. 5209.0:

- the make matrix which shows the output of commodities by domestic industries;
- the absorption matrix (sometimes referred to as the use matrix) which shows the usage of commodities (both domestic and imported);
- the imports matrix which shows the usage of those imported commodities which compete against domestically produced commodities; and
- the margins matrix which shows the difference between the values at purchasers' prices

and the basic values of all the flows in the absorption matrix.

These four basic matrices are used to derive the industry-by-industry flow matrices which provide the starting point for most input-output based analyses.

- The direct requirements coefficients matrices are calculated from the industry-by-industry flows matrices by expressing each flow into an industry as a percentage of the output of that industry. These coefficients can then be used to estimate the inputs required to produce any given amount of output of that industry.
- Using the direct requirements coefficients, it is possible to take into account the whole chain of production to calculate total requirements coefficients. For example, inputs from the mining industry are needed to produce output from the chemicals industry (first-round effects), but the mining industry itself needs inputs from the chemicals industry (second-round effects) and so on. The additional effects on the production of individual industries from each round can be taken into account and summed to produce "total requirements coefficients". Mathematically, this is equivalent to taking the Leontief inverse of Quadrant 1 of the direct requirements matrices, which is why the total requirement matrices are sometimes called the inverse matrices. The mathematical details are provided in cat. no. 5215.0.

Some countries also compile commodity-by-commodity tables, but Australia does not do so because the additional cost is not considered justified. The following discussion refers only to industry-by-industry tables.

**Input-output multipliers**

Input-output multipliers can be derived from the direct requirements coefficients matrices. The most basic kind of multiplier is the simple output multiplier, which is defined as the total value of production by all industries of the economy that is necessary to satisfy a one dollar change in final demand for the output of a particular industry. The total output multiplier also takes account of the household sector's increased expenditure leading to increased demand for the output of domestic industries. Other multipliers that can prove useful in analytical work include income multipliers, imports multipliers and employment multipliers.

**Definition of input-output industries**

It is desirable to choose input-output industries that are likely to remain fairly stable over time so that the input-output relationships between industries will also remain fairly stable. As well, input-output industries are defined to satisfy as far as possible the homogeneity assumption, which may be described as follows:

- each industry is defined so that all of its products are either perfect substitutes for one another or are produced in fixed proportions;
- each industry has its own unique input structure of commodity and primary inputs; and
- there is no substitution between the products output by the different industries.

While it might seem to be a good idea to define a large number of highly specialised industries, each producing a small number of characteristic commodities, there are a number of practical disadvantages in doing so. Businesses may not keep sufficiently detailed records, particularly for inputs. Also, while the first two homogeneity criteria might be better satisfied, it is likely that the

third would not. Most importantly, using a fine industry classification would require additional work, so that the resulting tables would cost more to produce and take longer to compile. On the other hand, if the industries were too broadly defined, the tables would be less useful to those users who wish to study relatively narrowly defined industries. The result is that the input-output tables produced in Australia attempt to strike a balance between cost, timeliness and the level of detail produced.

The upper limit to the number of possible compilation industries is the number of industries in ASIC but, in practice, input-output industries are defined by combining 4-digit ASIC industries. The industries for which data are published are determined by consulting with major users and by comparing our input-output industry classification with those used by our major trading partners. There will be 109 publication industries for the 1989-90 tables, the same ones as for 1986-87.

Some economic activities popularly thought of as "industries" are in fact activities that are carried out across a wide range of industries. For example, there is no "tourism" industry in ASIC or in the input-output industry classification. In the input-output framework, such "industries" have to be treated as consisting of parts of one or more input-output industries and users wishing to analyse them must make assumptions about the share of their activities within the totals for each of the input-output industries involved.

Another assumption underlying input-output estimates is the so-called "proportionality assumption". It states that any change in the output of an industry will lead to proportional changes in the quantities of its intermediate inputs (those goods and services supplied by other industries) and its primary inputs, such as wages. This assumption may be invalidated by economies of scale, technological change or substitution of factors (e.g. more capital, less labour).

**Data sources and levels of compilation and aggregation**

Much of the data used in the tables come from ABS economic censuses and surveys. The data are collected at the ASIC class (or 4-digit ASIC level). Over 400 industries are involved. For those industries not covered by ABS collections, other data sources such as taxation data, administrative by-product data and annual reports are used. However, the matrix showing the use of commodities by industry (the absorption matrix) is compiled for 109 industries, so that the tables can be produced as quickly as possible at the lowest cost.

ABS overseas trade collections provide very detailed commodity data for exports and imports of goods. Concordances are maintained between the trade, manufacturing production and input-output commodity classifications so that data from the different data sources can be compared, the commodities balanced, and the Australian supply of each commodity derived. A summary table showing the results of this process is provided as Table 1 in cat. no. 5215.0.

In practice, the raw data often do not satisfy the requirement that total supply must equal total demand. There are many reasons why this may be so, such as classification or timing problems. It is necessary to find the causes of the imbalances and rectify them. This is done for about 1200 different commodities. It is preferable to balance at this level than at, say, the commodity group level (109 commodity groups, one for each input-output industry), because it is easier to detect the causes of any imbalances that may occur.

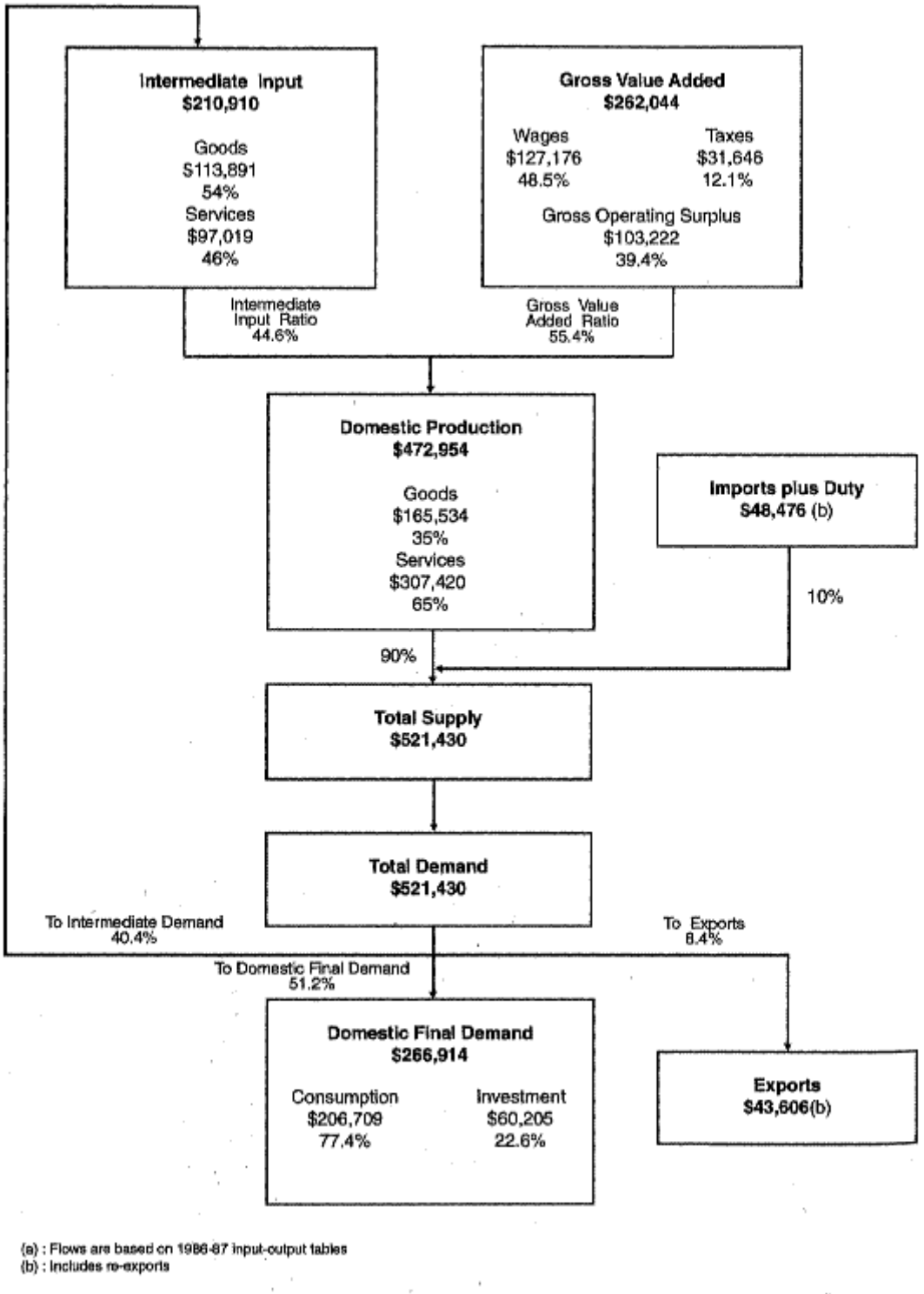
Data about margins (see the discussion in "Basic concepts" above) are also required for compiling input-output tables. The margins include wholesale, retail, and transport margins, as well as commodity taxes. A complete list can be found in Appendix F of 5209.0. Data about margins are obtained from ABS economic collections, from taxation data and from other sources such as annual reports of public authorities. Details of the margins for each commodity are shown in Table 4 of 5209.0 and in the detailed margin matrices described in Appendix F of cat.

no. 5209.0.

**Uses of input-output tables**

Figure 2 uses data from Table 11 of cat. no. 5209.0 to show, in graphical form, the flows of goods and services within the economy. Input-output data can be used to assess the overall effects on the economy of proposed initiatives such as changes in the mix of direct and indirect taxes or the introduction of new incentives for businesses to invest.

**FIGURE 2. THE AUSTRALIAN ECONOMY: FLOW OF GOODS AND SERVICES (a) ($MILLION)**




(a) : Flows are based on 1986-87 input-output tables
(b) : Includes re-exports

Input-output multipliers can be used to provide quick answers about the likely impacts of an increase in demand for the output of an industry, the likely impact of new projects and the likely results of import replacement strategies, not only on the industry itself but on all the other industries in the economy.

Care must be taken to use the multipliers correctly. In real-life situations, judgements have to be made about the extent to which the homogeneity and/or proportionality assumptions may or may not actually hold. For example, there might be unused production capacity, significant economies of scale, or technological changes for which allowances have to be made. In some industries, such as agriculture and insurance, seasonal conditions or natural disasters can result in the proportionality assumptions not holding.

For more complex or longer term analyses, it is often more appropriate to construct special models based on input-output data. In recent years, input-output models have been developed, both by government departments and by consultants in the private sector, to examine the effects of changes in taxation policy. The Industry Commission uses input-output models to examine the likely effects of changes to tariff policy. The Organisation for Economic Co-operation and Development (OECD) is using input-output methods in its structural analysis, or STAN project to measure the effects of technological change in OECD countries.

Another major use of the Australian input-output tables has been as a starting point for input-output tables for the States and Territories, and sometimes for smaller regions of Australia. Input-output analysis for detailed geographic areas has been used in assessing the effects of economic changes on industries such as the sugar industry.

The ABS will be reviewing its program of Input-Output statistics during the first half of 1993. The review will include an assessment of the user requirements for these statistics.

A more detailed description of input-output tables can be found in Section 19 of Australian National Accounts: Concepts, Sources and Methods (cat. no.5216.0). Queries should be directed to The Director, Supply Use Benchmarks, Australian Bureau of Statistics, P.O. Box 10, Belconnen ACT 2616; or by telephone on (02) 6252 6908**.**

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